AMENDMENTS

This listing of claims will replace all prior versions, and listings, of claims in the application:

<u>In the claims</u>

Claim 1 (original): An apparatus for conducting simultaneous endothermic and exothermic reactions, comprising a bicatalytic reactor cell,

wherein said bicatalytic reactor cell comprises a first reaction channel, a second reaction channel, and a thin metal, heat-conductive separator with first and second catalyst-coated surfaces, wherein said first reaction channel comprises at least a portion of the first catalyst-coated surface and said second reaction channel comprises at least a portion of the second catalyst-coated surface, wherein the catalyst on the first catalyst-coated surface comprises an exothermic reaction catalyst and the catalyst on the second catalyst-coated surface comprises an endothermic reaction catalyst, wherein heat generated by an exothermic reaction catalyzed by said exothermic catalyst on the first catalyst-coated surface is transferred through the thin metal separator to provide heat for an endothermic reaction catalyzed by said endothermic reaction catalyst on the second catalyst-coated surface.

Claim 2 (original): An apparatus as in claim 1, wherein said exothermic reaction is combustion and said endothermic reaction is steam reforming.

Claim 3 (original): An apparatus as in claim 1, wherein the separator comprises an iron chromium aluminum alloy

Claim 4 (original): An apparatus as in claim 1, wherein the separator comprises a nickel chromium aluminum alloy.

Claim 5 (original): An apparatus as in claim 1, wherein the thickness of the separator is between about 0.001 and 0.1 inch.

Claim 6 (original): An apparatus as in claim 1, wherein the thickness of the separator is between about 0.002 and 0.04 inch.

Claim 7 (original): An apparatus as in claim 1, wherein the thickness of the separator is between about 0.002 and 0.02 inch.

Claim 8 (original): An apparatus as in claim 1, wherein said catalysts are applied as washcoats to form said first and second catalyst-coated surfaces.

Claim 9 (original): An apparatus as in claim 1, wherein at least a portion of the first catalyst-coated surface and at least a portion of the second catalyst-coated surface are directly opposite one another on opposing sides of said separator.

Claim 10 (original): An apparatus as in claim 1, further comprising an inlet and an outlet for flow of a reaction stream through each reaction channel, wherein at least a portion of the separator is shaped to form corrugations, said corrugations comprising alternating ridges and grooves.

Claim 11 (original): An apparatus as in claim 10, wherein said corrugations form essentially straight channels in the direction of flow of the reaction stream from said inlet to said outlet.

Claim 12 (original): An apparatus as in claim 10, wherein said corrugations form a herringbone pattern in the direction of flow of the reaction stream from said inlet to said outlet.

Claim 13 (original): An apparatus as in claim 1, comprising a plurality of bicatalytic reactor cells, wherein said bicatalytic reactor cells are arranged in a stack, wherein said stack comprises adjacent, alternating first and second reaction channels, wherein said first reaction channels

comprise at least a portion of the first surfaces of two adjacent separators and said second reaction channels comprise at least a portion of the second surfaces of two adjacent separators.

Claim 14 (original): An apparatus as in claim 13, wherein the distance between two adjacent separators is between about 0.01 and 0.5 inches.

Claim 15 (original): An apparatus as in claim 13, wherein the distance between two adjacent separators is between about 0.02 and 0.25 inches.

Claim 16 (original): An apparatus as in claim 13, further comprising a transverse flow plate between each pair of separators, wherein each transverse flow plate comprises a hollow portion in the central portion of the plate to allow flow of a reaction stream through a reaction channel.

Claim 17 (original): An apparatus as in claim 16, further comprising a flow redirecting device in the hollow portion of each transverse flow plate.

Claim 18 (original): An apparatus as in claim 17, wherein the flow redirecting device comprises at least one grooved plate.

Claim 19 (original): An apparatus as in claim 17, wherein the flow redirecting device comprises a plurality of spheres fused together at their contact surfaces.

Claim 20 (original): An apparatus as in claim 13, further comprising an exothermic reaction stream in each of said first reaction channels and an endothermic reaction stream in each of said second reaction channels.

Claim 21 (original): An apparatus as in claim 20, further comprising an inlet and an outlet for said exothermic reaction stream, configured such that the flow of said exothermic reaction

stream through said inlet and said outlet is transverse to the flow of the exothermic reaction stream through each of the first reaction channels.

Claim 22 (original): An apparatus as in claim 20, further comprising an inlet and an outlet for said endothermic reaction stream, configured such that the flow of said endothermic reaction stream through said inlet and said outlet is transverse to the flow of the endothermic reaction stream through each of the second reaction channels.

Claim 23 (original): An apparatus as in claim 13, wherein said exothermic reaction is combustion and said endothermic reaction is steam reforming, wherein said steam reforming reaction produces hydrogen gas, wherein said hydrogen gas is fed into the anode of a fuel cell.

Claim 24 (previously presented): An apparatus as in claim 13, further comprising an endothermic reaction stream in at least one of said first reaction channels, an exothermic reaction stream in at least one of said second reaction channels, and a heater to preheat at least one reaction stream prior to its entry a reaction channel.

Claim 25 (withdrawn): A method for performing an endothermic and an exothermic reaction simultaneously, said method comprising:

passing an endothermic reaction stream and an exothermic reaction stream through a plurality of adjacent, alternating first and second reaction channels defined by spaced apart, thin metal, heat conductive separators, wherein each separator comprises first and second surfaces, wherein at least a portion of said first surface is coated with an exothermic reaction catalyst and at least a portion of said second surface is coated with an endothermic reaction catalyst,

wherein said first reaction channels comprise the first surfaces of two adjacent separators and said second reaction channels comprise the second surfaces of two adjacent separators;

catalyzing an exothermic reaction in said first reaction channels to generate heat, wherein said heat is transferred across the separators into said second reaction channels;

and catalyzing an endothermic reaction in said second reaction channels, wherein the endothermic reaction in the second reaction channels consumes the heat generated by the exothermic reaction in the first reaction channels.

Claim 26 (withdrawn): A method as in claim 25, wherein said exothermic reaction is combustion and said endothermic reaction is steam reforming.

Claim 27 (withdrawn): A method as in claim 25, further comprising preheating at least one reaction stream with a heater prior to its entry into a reaction channel.

Claim 28 (original): A continuous-flow catalytic plate reactor for performing an endothermic reaction and an exothermic reaction in adjacent isolated reaction chambers to supply the heat required by said endothermic reaction by said exothermic reaction, comprising:

a) a stack of catalyst-coated platelets interleaved with transverse-flow plates, each of said catalyst-coated platelets and said transverse-flow plates comprising four apertures arranged in a spaced, substantially rectangular array and disposed as a first pair of apertures adjacent one end and a second pair of apertures adjacent a spaced, opposed end, all four apertures of one plate being aligned with all four apertures of all other plates of said stack;

b) each of said catalyst-coated platelets being impermeable to gas flow through said platelets and each having a coating of catalyst for said exothermic reaction on one side and a coating of catalyst for said endothermic reaction on the other side;

c) each of said transverse-flow plates includes a void region medial in said plate joining only one of said pairs of apertures to expose said catalyst coatings on both adjacent catalyst-coated platelets, which platelets form the side walls of said flow plate void region to define a reaction zone therebetween, said transverse-flow plates alternating between those in which said void region joins said first pair of apertures and those in which said void region joins said second pair of apertures;

d) said apertures and reaction zones defining two non-commingling flow paths through said stack;

e) the first of such flow paths extending from one of the aligned apertures of said first pair through the reaction zone of every second traverse-flow plate while passing over said coating of catalyst for said exothermic reaction to the remaining one of the first pair of aligned apertures; and

f) the second of such flow paths extending from one of the aligned apertures of said second pair through all remaining reaction zones while passing over said coating of catalyst for said endothermic reaction to the remaining one of the second pair of aligned apertures.

Claim 29 (original): A continuous-flow catalytic plate reactor as in claim 28 in which said first pair of apertures is arranged diagonally in said rectangular array and said second pair of apertures is arranged diagonally in said rectangular array transverse to said first pair.

Claim 30 (original): A continuous-flow catalytic plate reactor as in claim 28 in which one of said aligned apertures in each pair is defined as a feed channel and the remaining one of said aligned apertures in each pair is defined as a product channel, and wherein said feed channel is terminated by a flow stopping member to force flows from said feed channel through said reaction zone to said product channels.

Claim 31 (original): A continuous-flow plate reactor as in claim 28 in which said catalyst-coated platelets are substantially thinner than said transverse-flow plates.

Claim 32 (original): A continuous-flow plate reactor as in claim 28 in which the void region of every traverse-flow is partially filled with means for redirecting gas flow into contact with at least some of said catalyst coated on said reaction zone side wall.

Claim 33 (original):A continuous-flow plate reactor as in claim 32 wherein said flow directing means comprises a grooved metal plate.

Claim 34 (original): A continuous-flow plate reactor as in claim 32 wherein said flow directing means comprises metal or ceramic spheres.

Claim 35 (original): A continuous-flow plate reactor as in claim 28 wherein said separator platelets comprise an aluminum-containing alloy comprising at least one of iron, nickel, chromium, and cobalt coated with catalyst.

Claim 36 (original): A catalytic plate reactor as in claim 28 wherein said coating of catalyst for said exothermic reaction is a combustion catalyst, and said catalyst for said endothermic reaction is a steam reforming reaction catalyst

Claim 37 (withdrawn): A method for performing an endothermic reaction and an exothermic reaction simultaneously in isolated adjacent reaction chambers to supply heat required for said endothermic reaction by said exothermic reaction, said method comprising:

a) passing an endothermic reaction feed gas stream and an exothermic reaction feed gas stream through a stack of generally planar reaction zones comprising catalyst-coated platelets interleaved with relieved transverse-flow plates, each of said catalyst-coated plates and said transverse-flow plates comprising four apertures arranged in a substantially rectangular array and defined as a first pair of apertures and a second pair of apertures, all four apertures of one plate being aligned with all four apertures of all other plates of said stack;

b) each of said catalyst-coated platelets being impermeable to gas flow other than through said apertures and each having a coating of catalyst for said exothermic reaction on one side and a coating of catalyst for said endothermic reaction on the other side;

c) each of said transverse-flow plates further comprising a void region medial thereof which joins only one of said pairs of apertures to expose said catalyst coatings on both adjacent catalyst-coated plates and form a reaction zone therein, said transverse-flow plates alternating between those in which said reaction zone joins said first pair of apertures and those in which said reaction zone joins said second pair of apertures;

d) said endothermic reaction feed stream and said exothermic reaction feed stream are fed through two non-commingling flow paths through said stack;

e) the first of such flow paths extending from one of said aligned apertures of said first pair through the reaction zone of every second transverse-flow plate while passing over said coatings of catalyst for said exothermic reaction to the remaining one of said aligned apertures of said first pair;

f) the second of such flow paths extending from one of said aligned apertures of said second pair through all remaining reaction zones while passing over said coatings of catalyst for said endothermic reaction to the remaining one of said aligned apertures of said second pair;

g) generating heat at said coatings of catalyst for said exothermic reaction and conducting said exothermic heat through said separator platelets directly to said coatings of catalyst for said endothermic reaction to accelerate said endothermic reaction.

Claim 38 (withdrawn): A method in accordance with claim 37 in which said first pair of apertures is arranged diagonally in said rectangular array and said second pair of apertures is arranged diagonally in said rectangular array transverse to said first pair.

Claim 39 (withdrawn): A method in accordance with claim 37 in which said exothermic reaction is a combustion reaction and said coating of catalyst for said exothermic reaction is a combustion catalyst, and said endothermic reaction is a steam reforming reaction and said catalyst for said endothermic reaction is a steam reforming reaction catalyst.

Claim 40 (withdrawn): A method of producing a catalytic wall plate reactor comprising the steps of:

a) brazing two transverse-flow plates to opposite faces of a thin metal platelet to make a sub-assembly;

b) coating at least a portion of the exposed surface of one side of the thin metal platelet with a combustion catalyst;

c) coating at least a portion of the exposed surface of the opposite side of the thin metal plate with a reforming catalyst;

d) cleaning the exposed surfaces of the transverse-flow plates; and

e) brazing a stack of the subassemblies to form a plate reactor.

Claim 41 (withdrawn): A method of producing a catalytic wall plate reactor comprising the steps of:

a) brazing a metal frame to each of opposite faces of a transverse-flow plate to make a sub-assembly;

b) coating at least a portion of one side of a thin metal platelet with a combustion catalyst;

c) coating at least a portion of the opposite side of the thin metal platelet with a reforming catalyst, said bi-catalyst coated platelet forming a separator platelet; and

d) forming a stack of catalyst coated platelets interleaved with said subassemblies, including placing inert, thermally resistant gaskets between the subassemblies and separator platelets.

Claim 42 (original): A modular reactor sub-assembly for a continuous flow plate reactor comprising in operative combination:

a) a separator platelet having a first surface and a second surface on the obverse side thereof, a longitudinal dimension terminating in first and second ends, and a lateral dimension generally orthogonal thereto terminating in first and second side edges;

b) said platelet having deposited on selected areas on at least one of said first and said second surfaces a coating of at least one catalyst compositions, said catalyst compositions being selected from the same or different compositions;'

c) at least one first reactant gas flow plate disposed on said first side of said first separator plate;

d) at least one second reactant gas flow plate disposed on said second side of said first

separator plate;

e) each of said first and second flow plates having a relieved area therein substantially corresponding to said selected catalyst composition coated area, said relieved area providing a generally planar reaction zone bounded on one side thereof by said separator platelet selected catalyst coating; and

f) said separator plate and said flow plates having aligned apertures generally located at apposed ends to provide passage of feedstock gases into and out of the respective reaction zones without short circuit and maintaining separate feed streams flow into and out of the respective zones, said gases flow in said reaction zones being selected from co-flow and counterflow.

Claim 43 (original): A modular reactor assembly as in claim 42 wherein said catalyst composition coating on said first platelet surface is different from said catalyst composition coating on said second platelet surface.

Claim 44 (original): A modular reactor subassembly as in claim 43 wherein at least one of said flow plate reaction zones includes means for directing gas flow into contact with said catalyst coating separator plate surface.

Claim 45 (original): A modular reactor subassembly for a continuous flow plate reactor comprising in operative combination:

a) at least one generally planar first reactant gas flow plate having a first face and a second face on the obverse side thereof, a longitudinal dimension terminating in first and second ends, and a lateral dimension generally orthogonal thereto terminating in first and second edges;

b) said at least one flow plate having a relieved area therein medial of said ends and edges, said area defining a generally planar reaction zone between said faces;

c) a first, generally planar separator platelet disposed on said first face of said flow plate and a second generally planar separator platelet disposed on said second face of said flow plate, said platelets defining side walls for said reaction zone;

d) said platelets each having a first surface and a second surface on the obverse side thereof; at least one of said first surfaces having deposited on selected areas a coating of at least one catalyst composition, said catalyst composition being selected from the same or different compositions and said selected areas of coating being aligned with and not extending beyond said flow plate reaction zone relieved area, and said first surfaces of said platelets on opposed faces of said flow plate facing each other with said at least one catalyst coated platelet area exposed in said reaction zone; and

e) said flow plate and said separator platelets having aligned apertures generally located at apposed ends to provide passage of feedstock gases into and out of said reaction zone.

Claim 46 (original): A modular reactor subassembly as in claim 45 wherein both said first surfaces of said platelets are coated with the same catalyst composition.

Claim 47 (original): A modular reactor subassembly as in claim 46 wherein both said second surfaces of said platelets are coated with the same catalyst composition, which composition is selected from the same or different catalysts as coated on said first surfaces of said platelets.

Claim 48 (original): A modular reactor subassembly as in claim 46 wherein said flow plate reaction zone includes means for directing gas flow into contact with at least a portion of the catalyst composition on at least one of said first separator platelet surfaces.

Claim 49 (previously presented): An apparatus according to claim 23, wherein said fuel cell is a power source for a vehicle.